AD-A034 668 ARMY ENGINEER WATERWAYS EXPERIMENT STATION VICKSBURG MISS F/G 8/13
SUMMARY OF SPECIAL EQUIPMENT FOR LABORATORY SOILS TESTING AT U.--ETC(U)
MAY 71

UNCLASSIFIED WES-MP-S-71-16 NL

1 OF 1
AD-A
034 668

END
DATE
FILMED
3-5-77
NTIS

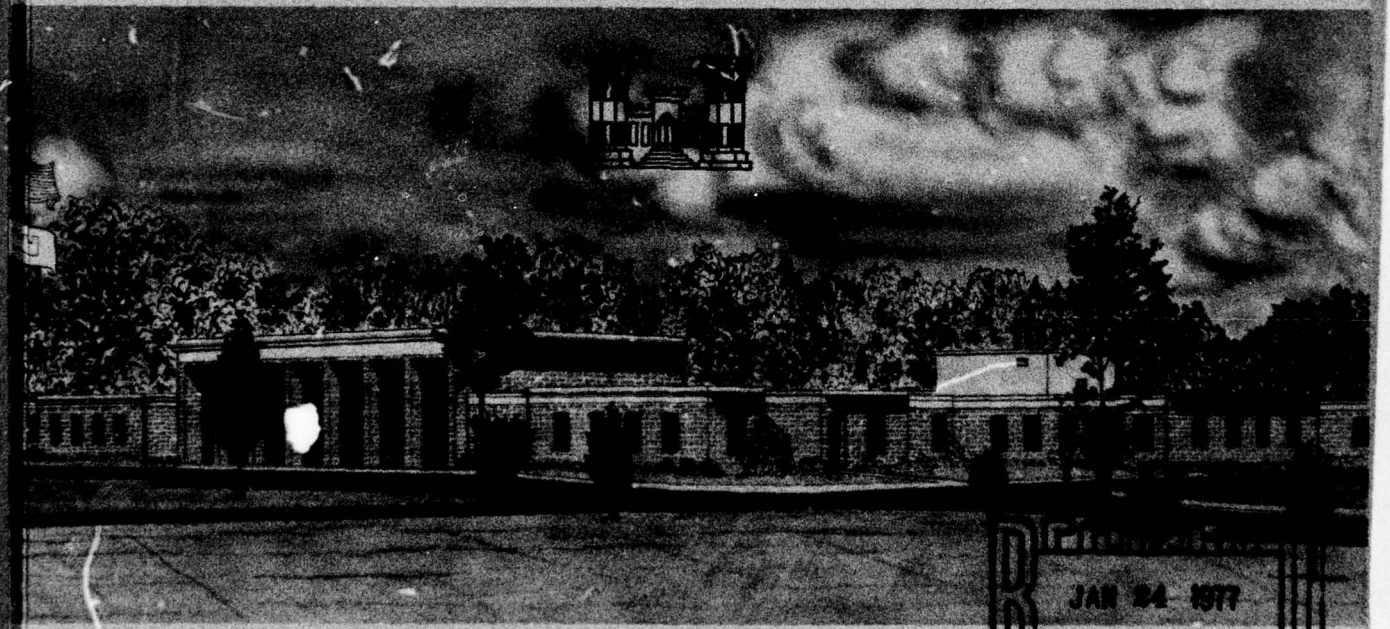
SUMMARY OF SPECIAL EQUIPMENT FOR LABORATORY SOILS TESTING AT U.S. ARMY CORPS OF ENGINEERS

Army Engineer Waterways Experiment Station
Vicksburg, Mississippi

May 1971

MISCELLANEOUS PAPER S-71-16

SUMMARY OF SPECIAL EQUIPMENT FOR LABORATORY SOILS TESTING AT U. S. ARMY CORPS OF ENGINEERS DIVISION LABORATORIES



May 1971

Sponsored by Office, Chief of Engineers, U. S. Army

Conducted by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi

APPR[illegible] UNLIMITED

Destroy this report when no longer needed. Do not return it to the originator.

The findings in this report are not to be construed as an official Department of the Army position unless so designated by other authorized documents.

Unclassified
Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) U. S. Army Engineer Waterways Experiment Station Vicksburg, Mississippi	2a. REPORT SECURITY CLASSIFICATION Unclassified 2b. GROUP

3. REPORT TITLE

SUMMARY OF SPECIAL EQUIPMENT FOR LABORATORY SOILS TESTING AT U. S. ARMY CORPS OF ENGINEERS DIVISION LABORATORIES

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

Final report

5. AUTHOR(S) (First name, middle initial, last name)

6. REPORT DATE May 1971	7a. TOTAL NO. OF PAGES 18	7b. NO. OF REFS 2
8a. CONTRACT OR GRANT NO. b. PROJECT NO. c. d.	9a. ORIGINATOR'S REPORT NUMBER(S) Miscellaneous Paper S-71-16 9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)	

10. DISTRIBUTION STATEMENT

Approved for public release; distribution unlimited.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY Office, Chief of Engineers, U. S. Army Washington, D. C.

13. ABSTRACT

This publication lists most of the various special laboratory testing equipment found in Corps of Engineers Division Laboratories in the continental United States, i.e., generally equipment in addition to the normal complement required for performance of the laboratory soils tests described in Engineer Manual 1110-2-1906, "Laboratory Soils Testing," dated 30 November 1970. The Corps of Engineers Divisions for which special equipment is listed are: Missouri River Division, New England Division, North Central Division, North Pacific Division, Ohio River Division, South Atlantic Division, South Pacific Division, and the Southwestern Division. Special laboratory soil testing equipment at the U. S. Army Engineer Waterways Experiment Station is described in "Soil Mechanics Testing Facilities at the Waterways Experiment Station," dated October 1970, copies of which were distributed to all divisions and districts.

DD FORM 1 NOV 68 1473 REPLACES DD FORM 1473, 1 JAN 64, WHICH IS OBSOLETE FOR ARMY USE.

Unclassified
Security Classification

Unclassified
Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Laboratory tests Soils tests Soils testing equipment						

Unclassified
Security Classification

MISCELLANEOUS PAPER S-71-16

SUMMARY OF SPECIAL EQUIPMENT FOR LABORATORY SOILS TESTING AT U. S. ARMY CORPS OF ENGINEERS DIVISION LABORATORIES

May 1971

Sponsored by Office, Chief of Engineers, U. S. Army

Conducted by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi

ARMY-MRC VICKSBURG, MISS.

THE CONTENTS OF THIS REPORT ARE NOT TO BE USED FOR ADVERTISING, PUBLICATION, OR PROMOTIONAL PURPOSES. CITATION OF TRADE NAMES DOES NOT CONSTITUTE AN OFFICIAL ENDORSEMENT OR APPROVAL OF THE USE OF SUCH COMMERCIAL PRODUCTS.

FOREWORD

This publication was prepared for the Office, Chief of Engineers (OCE), by the U. S. Army Engineer Waterways Experiment Station (WES) under Engineering Studies Item ES 516, "Evaluation of Soil Mechanics Laboratory Equipment and Testing Procedures." Preparation was specifically directed by OCE 1st Ind dated 14 September 1970 to WES (WESSE) letter dated 1 September 1970, subject: Preparation of Brochure on Special Equipment for Laboratory Soils Testing.

The publication is a brief summary of brochures on special equipment for laboratory soils testing submitted to OCE in early 1970 by the various Corps of Engineers' divisions.

Director of the WES during the preparation and publication of this report was COL Ernest D. Peixotto, CE. Technical Director was Mr. F. R. Brown.

CONTENTS

SUMMARY OF SPECIAL EQUIPMENT FOR LABORATORY SOILS TESTING AT U. S. ARMY CORPS OF ENGINEERS DIVISION LABORATORIES

PART I: INTRODUCTION

1. This publication lists most of the various special laboratory testing equipment found in Corps of Engineers Division Laboratories in the continental United States, i.e., generally equipment in addition to the normal complement required for performance of the laboratory soils tests described in Engineer Manual 1110-2-1906, "Laboratory Soils Testing," dated 30 November 1970.

2. The Corps of Engineers Divisions for which special equipment is subsequently listed are: Missouri River Division (MRD), New England Division (NED), North Central Division (NCD), North Pacific Division (NPD), Ohio River Division (ORD), South Atlantic Division (SAD), South Pacific Division (SPD), and the Southwestern Division (SWD). Special laboratory soil testing equipment at the U. S. Army Engineer Waterways Experiment Station (WES) is described in "Soil Mechanics Testing Facilities at the Waterways Experiment Station," dated October 1970, copies of which were distributed to all divisions and districts.

PART II: SPECIAL EQUIPMENT LISTS

Compaction Testing of Material Containing Large Particles

Impact compaction apparatus

3. SAD. Compaction mold, 12 in. in diameter by 12 in. high. Sliding weight, fixed-head rammer, 4-in.-diam foot, 11.5-lb falling weight, 24-in. height of drop. Hand-operated.

4. SPD. Compaction mold, 12 in. in diameter by 10 in. high. Sliding weight, fixed-head rammer, 8-in.-diam foot, 30-lb falling weight, 18-in. height of drop. Hand-operated.

5. SWD (Albuquerque District). Mechanical compactor (manufactured by Howard & Company, South San Francisco, Calif.) with 5.5-, 11.5-, 24.7-, and 55.6-lb rammers with 2-, 4-, 6-, and 9-in.-diam feet, respectively. Self-compensating heights of drop variable between about 4 to 5 in. and 24 in. Delivers blows at rate of 29 per min. Molds, 6, 12, and 18 in. in diameter with heights of 4.5, 12, and 18 in., respectively, are rotated manually for even distribution of blows. Five-digit blow counter automatically stops device at end of set count.

Vibratory compaction apparatus

6. NPD. One-cu-yd compaction mold, 4.2-in. ID, with hemispherical bottom. Accepts 3/4-cu-yd specimen. Inflatable 10-psi air bag provides surcharge pressure. Vibrating table actuated by Syntron RV-9812 vibrator supported by 60-psi air ride springs. Built for density control of gravelly materials at Cougar Dam.

7. SPD. The 12-in.-diam compaction mold described in paragraph 4 can be mounted on either a Syntron VP80 or VP240 vibrating table. Surcharge weights up to 3 psi are applied.

Consolidation Testing

High-capacity consolidometers

8. MRD. Eight positions. Lever system, hardened steel knife edges.

100-to-1 ratio permits pressures up to 64 tons per sq ft on 4.28-in.-diam specimen; floating-ring consolidometers generally used; 3-in.-diam floating rings also available. The 2-in.-diam fixed rings permit pressures up to 350 tons per sq ft. Hand wheels and screen jacks maintain lever systems level.

9. NED. Six positions: 2-position, Soiltest, Inc.; 4-position, Hogentogler and Co., Inc. Lever systems provide pressures up to 52 tons per sq ft on 4.45-in.-diam specimens. Floating-ring consolidometer, sometimes used as fixed-ring type. 5.875-in.-diam rings also available.

10. SAD. Two positions. Hydraulic system maintains pressures between 0.10 and 350 tons per sq ft on 4-in.-diam specimens. Fixed-ring consolidometers generally used although apparatus is adaptable to any size or type consolidometer.

11. SWD. Twenty positions. Lever system, hardened steel knife edges. 40-to-1 ratio permits pressures up to 64 tons per sq ft on 4.44-in.-diam specimen, 256 tons per sq ft on 2.22-in.-diam specimen. Hand wheels and screw jacks maintain lever systems level. Fixed-ring consolidometers.

Back-pressure consolidometers

12. NED. Two Anteus Back-Pressure Consolidometers, Models A* and A-1. Consolidation pressures up to 16 tons per sq ft on 4.0-in.-diam specimen, 32 tons per sq ft on 2.5-in.-diam specimen, provided pneumatically by rolling rubber diaphragm. Back pressure to 100 psi.

13. ORD. One Anteus Model A.

14. SWD. One Anteus Model A.

Large consolidometers

15. SPD. Primarily used for testing rock fill. Fixed-ring, 12-in.-diam consolidometer made of stainless steel, wall thickness 1-1/8 in. Specimen is 13 in. high. Seepage saturation by standpipe to bottom of specimen. Load frame applies maximum load of 60 tons (47 tons per sq ft on 12-in.-diam specimen) by hydraulic cylinder powered by compressed

---

* See WES Miscellaneous Paper No. 3-478, "Evaluation of Soil Mechanics Laboratory Equipment, Report 11, Anteus Back-Pressure Apparatus, Model A," L. Devay, Vicksburg, Miss., Jan 1970.

nitrogen-boosted hydraulic system. Strain as well as stress control can be used if testing 6-in.-diam triaxial specimens. Loads measured by 200,000-lb capacity Martin Decker load cell with dial ranges of 6,000, 30,000, and 200,000 lb.

16. SPD plans to convert to floating-ring consolidometer, reducing height of specimen to 8 or 9 in.

Direct Shear Testing

Repeated direct shear apparatus

17. MRD. One single-position and three double-position apparatus. Normal stresses up to 30 tons per sq ft applied to 3-in.-sq specimen up to 1 in. thick by pneumatic rolling rubber diaphragm. Bottom half of shear box fixed; upper half of shear box driven by variable speed drive permitting rates of deformation between 0.1 and 3 in. per day; rate can be varied over wider range by simple gear change. Shear displacements up to 0.5 in. to either side of center of specimen. Eccentricity of normal load minimized by using very long tie rods to connect fixed pneumatic piston to specimen loading piston. Shear forces applied by ball screw jack and measured by load rings or electrical load cell.

18. NPD. a. One single-position apparatus. Normal stresses up to 12 tons per sq ft on 3-in.-sq specimen up to 3/4 in. thick. Bottom half of shear box fixed to platform of a Fairbanks scale which is moved by a reversible Zero-Max variable speed unit. Top half of shear box is fixed, and the shear foce measured by a load ring. Push and pull bars alternately attached to load ring and upper half of shear box as direction of shear is reversed.

b. One double-position apparatus. Essentially same as above, consisting of two Fairbanks platform scales rigidly connected in tandem. One Zero-Max speed control drives scales in one direction, while another drives scales in the opposite direction.

19. SAD. Two double-position apparatus. Normal stress capacity of 20 tons per sq ft on 3-in.-sq by up to 1-in.-high specimen applied by

pneumatic system. Up to 39 tons per sq ft can be achieved with minor modifications. Stainless steel shear boxes; bottom half fixed, top half is driven (pushed) by Graham electric variable speed transmission through gear and chain system. Rates of shear deformation variable between 0.1 and 0.0001 in. per min. Shear deformations of 0.175 in. to either side of center of specimen. Direction of shear reversed by removing one chain and attaching another. Shear force measured by load ring.

20. SWD. Eighteen routine testing positions can be quickly adapted in minutes for repeated direct shear testing of 3-in.-sq or 4-in.-sq specimens up to 1 in. in height. Normal stresses up to 14 tons per sq ft applied using load hangers and dead weights. Lower halves of the shear boxes fixed, while upper halves alternately pulled and pushed by Zero-Max variable speed controls with chain and sprocket systems. Direction of shear reversed by crossing (looping) the chain on a small drive sprocket. Rates of horizontal displacement variable to as low as 5×10^{-6} in. per min. Shear forces measured by load rings.

Cyclic direct shear apparatus

21. SWD. Fully automatic system for direct shear machine alternates both normal and shear stresses between pre-selected values at regular time intervals.

Single plane direct shear apparatus for testing rock cores

22. ORD. Aluminum shear boxes accept full diameter (6 in.) cores sawed to approximately 3-1/2-in. lengths. Specimens grouted into shear boxes with hydrostone. Normal stresses to 365 psi (on 6-in.-diam specimen) applied by heavy steel coil spring. Shear forces (usually controlled stress) supplied by universal testing machine. Smaller apparatus for testing NX-size cores also available.

Triaxial Shear Testing

Conventional loading
6-in.-diam specimens

23. MRD. One Warlam-type apparatus, modified by replacing hydraulic loading system with 10,000-lb maximum capacity screw jack for controlled strain testing; variable speed control. Loading frame equipped with 20,000-lb maximum capacity aluminum load ring. Two reinforced lucite chambers, lateral pressure capacity of 400 psi. Back-pressure capacity of 150 psi. Dynisco electrical pressure transducers and Baldwin-Lima-Hamilton (BLH) strain indicator used for monitoring pore water pressures. For tests of durations in excess of 8 hr, strip-chart recorder used to automatically record axial load, axial deformation, and induced pore water pressure. Used for Q, R, and $\bar{R}$ testing.

24. NED. Nine modified Warlam-type chambers and control units; two Warlam-type loading apparatus, modified by replacing hydraulic loading systems with Duff-Norton worm gear jacks operated by Bodine direct current motors. Rates of vertical deformation variable between 0.002 and 0.200 in. per min using Minarik speed-control disks. Loading frames equipped with 20,000-lb maximum capacity aluminum load rings; 60,000-lb maximum capacity or 300,000-lb maximum capacity BLH loading machines used for axial loads exceeding 20,000 lb.

25. Aluminum chambers designed for lateral pressures up to 400 psi. Back-pressure capacity is 100 psi. Each equipped with Dynisco and CEC electrical pressure transducers for monitoring pore pressure response during back-pressure saturation and measuring pore water pressures induced during shear; readings obtained using Schaevitz Bytrex strain indicator and 10-channel BLH Model 225 sensing and balancing unit. Used for Q, R, $\bar{R}$, and S testing.

26. NCD. Two chambers, one loading frame with two loading positions. Hydraulic loading system includes electric pump with accumulator to minimize pulsation; one position has 25,000-lb axial load capacity, while other has 30,000-lb capacity; rates of deformation variable between 0.005 and 2 in. per min. Aluminum chambers have lateral pressure capacity of 300 psi.

Back-pressure capacity is 200 psi. Four-in.-diam platens also available. Used for R, $\bar{R}$, and S testing.

27. NPD. One Warlam-type aluminum chamber with lateral pressure capacity of 400 psi. Back-pressure capacity is 200 psi. Back pressure and induced pore pressure monitored by CEC No. 4-326 electrical pressure transducer and 7-channel readout manufactured by AV Corp., Seattle, Wash. Four-in.-diam platens available. Axial loading provided by 440,000-lb capacity BLH universal testing machine.

28. ORD. One Soiltest, Inc., steel chamber and loading device. Axially loaded hydraulically--hydraulic load cell capacity of 24,000 lb. Chamber has lateral pressure capacity of 400 psi. Back pressure to 200 psi. Pore water pressures monitored by electrical pressure transducer.

29. SAD. Two chambers 400-psi lateral pressure capacity and two loading devices. Back-pressure capacity is 150 psi. One loading device uses hydraulic ram with capacity of 80,000 lb; other uses variable-speed electric transmission with capacity of 10,000 lb through a load ring assembly; both permit constant strain loading. Four-in.-diam platens available. CEC electrical pressure transducers with Cox Instruments Corp. digital indicators used for monitoring pore water pressures. Used for Q, R, $\bar{R}$, and S testing.

30. SPD. Three Warlam-type aluminum chambers--lateral pressure capacity 55 tons per sq ft--back pressure to 14 tons per sq ft. One chamber equipped to measure pore water pressures at midpoint of specimen by inserting 1/16-in.-OD nylon tubing probe into specimen. Pore water pressures are measured by Bourdon gage and null balance. Null balance and Bourdon gage or electrical pressure transducers with direct read Berkeley EPUT meter and digital printout used for pore water pressure measurements with remaining chambers. Oversized platens for use with lubricated specimen ends, and 4-in.-diam platens are available. Axial loading is by 70,000-lb capacity Baldwin universal testing machine.

31. SWD. Three chambers for Q, R, $\bar{R}$, and S testing.

Conventional loading
12-in.-diam specimens

32. NPD. One chamber, lateral pressure capacity of 100 psi (design by SPD). Can also be used with Warlam panel for back-pressure and pore pressure measurements. Axial loading by Baldwin universal testing machine. Used primarily for S testing.

33. SPD. One chamber with lateral pressure capacity of 36 tons per sq ft and one chamber with lateral pressure capacity of 9 tons per sq ft. Back pressure to 14 tons per sq ft. Induced pore water pressure normally measured by Bourdon gages and null balances. Byron-Jackson electrical pressure transducers of 100 psi capacity can be embedded at five locations in specimen; outputs of transducers (pore water pressures) are read using direct-read Berkeley EPUT meter and digital printout. Loading is by 200,000-lb capacity Baldwin universal testing machine equipped with a load-deformation X-Y recorder.

Conventional loading
15-in.-diam specimens

34. SAD. One Soiltest apparatus with lateral pressure capacity of 400 psi. Back-pressure capacity is 150 psi. Pore pressures monitored using Geonor null balance device. Axial loads applied by 200,000-lb capacity hydraulic ram. Specimens compacted in split mold using Syntron VP-240 vibratory table or using hand rammer.

Cyclic loading

35. NCD. Five control consoles and nine lucite chambers of 120 psi lateral pressure capacity for testing 6-in.-diam specimens; back pressures to 60 psi. Each loading frame has hydraulic double-acting ram for axial loads to 20,000 lb. Axial load, lateral pressure, and back pressure can be automatically increased, retained, and decreased to established limits within set times; sequence is then repeated. After cycling, can be transferred to compression machine for axial loading to 150,000 lb. With slight modification, can be used for testing 4-in.-diam specimens.

Permeability Testing of Materials Containing Large Particles

36. SAD. One permeameter, 14 in. in diameter by 15 in. high, for testing earth-rock mixtures. Constant or falling head.

37. SPD. One permeameter, accepts specimens 18 in. in diameter by 6 to 18 in. high, primarily for gravel and crushed rock materials of medium to high permeability. Compaction of specimens by 30-lb sliding weight rammer. Constant or falling head. Periphery of undisturbed specimens is sealed with bentonite.

Sedimentation Analysis

38. MRD. Light beam, photoelectric cell, and closed-loop instrumentation system permit automatic tracking of sand accumulation in bottom of a tube. Curve is drawn on drum recorder by pen which follows tracking device.*

39. SAD. Tracking accomplished manually by viewing accumulation through low-power microscope. Curve drawn on drum recorder by pen which follows tracking device.

---

* Further information provided in Technical Memorandum No. 1-68 which may be obtained from MRD.